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IMPORTANCE OF CAPITAL MARKET EFFICIENCY FOR ECONOMIC GROWTH: THE CASE OF SERBIA

The aim of this paper is to examine whether the stock market in Serbia is a weak-form efficient, considering the fact that capital markets have huge importance in accelerating economic growth and development. Hence, tests of random walk theory are employed. The Ljung-Box test for linear dependence, the BDS test for non-linear dependence and ARCH LM test for ARCH effects, the unit root tests and the Lo and MacKinlay's variance ratio test are applied on the series of daily returns of the two indices on Belgrade Stock Exchange — BELEX15 and BELEXline. The obtained results indicate that the stock market in Serbia do not follow a random walk. Thus, the final conclusion is that the BSE is not weak-form efficient and represents an enormous obstacle for economic growth.

Keywords: *economic growth; capital allocation; stock returns; weak-form market efficiency.*

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ВАЖЛИВІСТЬ ЕФЕКТИВНОСТІ РИНКУ КАПІТАЛУ ДЛЯ ЕКОНОМІЧНОГО РОЗВИТКУ: ПРИКЛАД СЕРБІЇ

У статті досліджено питання, чи є фондовий ринок Сербії ефективним ринком слабкої форми, враховуючи той факт, що ринки капіталу мають величезне значення у прискоренні економічного зростання і розвитку. Застосовано тест теорії випадкових блукань. Для рядів щоденної рентабельності двох індексів на Белградській біржі — BELEX15 і BELEXline — застосовано тести Льюнга-Бокса для лінійної залежності, тест Брока-Дехерта-Шейнкмана для нелінійної залежності, тест ARCH LM для ARCH-ефектів, критерій одиничних коренів і тест дисперсійного відношення Ло-МакКінлі. Отримані результати показали, що фондовий ринок Сербії не схильний до випадкових блукань. Основний висновок: Белградська біржа не є ефективним ринком слабкої форми і є великою перешкодою для економічного зростання.

Ключові слова: *економічне зростання; розподіл капіталу; рентабельність акцій; ефективність ринку слабкої форми.*

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ВАЖНОСТЬ ЭФФЕКТИВНОСТИ РЫНКА КАПИТАЛА ДЛЯ ЭКОНОМИЧЕСКОГО РАЗВИТИЯ: ПРИМЕР СЕРБИИ

В статье исследуется вопрос, является ли фондовый рынок Сербии эффективным рынком слабой формы, учитывая тот факт, что рынки капитала имеют огромное значение в ускорении экономического роста и развития. Был применен тест теории случайных блужданий. Для рядов ежедневной рентабельности двух индексов на Белградской бирже — BELEX15 и BELEXline — применены тесты Льюнга-Бокса для линейной зависимости, тест Брока-Дехерта-Шейнкмана для нелинейной зависимости, тест ARCH LM для ARCH-эффектов, критерий единичных корней и тест дисперсионного отношения Ло-МакКинли. Полученные результаты показали, что фондовый рынок Сербии не подвержен случайным блужданиям. Основной вывод: Белградская биржа не является эффективным рынком слабой формы и представляет собой большое препятствие для экономического роста.

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Ключевые слова: *экономический рост; распределение капитала; рентабельность акций; эффективность рынка слабой формы.*

1. Introduction. Under the contemporary circumstances the existence of financial markets is a necessity and their significance is in every sense immense. Financial markets have favourable influence on the increase of additional savings and at the same time enable large institutional investors to diversify their portfolios at the international capital markets. But the greatest importance of financial markets comes from the fact that adequately structured financial markets, without obstacles in the performance, increase the confidence of participants as well as profitability, effectiveness, efficiency and prosperity of the economy. According to Ewah et al. (2009), the rate of economic growth of any nation is inseparably linked to the sophistication of its financial market and specifically its capital market efficiency. An efficient capital market can promote economic growth and prosperity by stabilizing the financial sector and providing an important investment channel that contributes to the attraction of domestic and foreign capital. Thus, the value of capital market lies in its financial intermediation capacity to link the deficit sector with the surplus sector of the economy. The absence of such capacity deprives the economy of investments and production of goods and services vital for social improvement. In the cases when the market operates efficiently, the trust is formed in the minds of public, and investors will be ready to invest in securities with the hope to achieve the returns on their investments in the future.

The theoretical explanation on the nexus between capital market and economic growth is further extended using efficient market hypothesis (EMH) developed by Fama in 1965. The EMH asserts that financial markets are efficient, meaning that share prices already reflect all known information. This strong version of the hypothesis requires that costs of trading securities, as well as finding and analysing information are always zero, which is surely false, but as Fama (1991) explained it is good as a benchmark in determining what reasonable information and trading costs are. Jensen (1978) suggested a weaker form of the hypothesis according to which prices reflect information to the point where marginal benefits of acting on information do not exceed marginal costs.

Market efficiency has been in the centre of the debate in financial literature and among practitioners for several decades. However, the evidence from numerous studies has been contradictory. A huge number of studies provide evidence to support the weak form efficiency for developed markets and reject it for emerging and developing countries. In developing countries capital markets are too narrow due to the insufficiently developed regulatory and institutional agreements, and share prices have long-term memory and dependence. Thus, investors will have no interest to invest in those markets, which will result in negative influence upon economic growth.

The raising consideration for testing emerging markets efficiency has been the result of the globalisation of financial markets.

Several studies have been conducted for testing market efficiency of the Athens Stock Market (ASM). Panas (1990) observed monthly data of 10 stocks listed at ASM from January 1965 to December 1984. By applying autocorrelation function and Ljung-Box statistics, the independence of successive log price changes for the 10 stocks was investigated and the results provided support for the existence of independence. Additionally, Panas performed tests for randomness and normality for each individual stock return and concluded the ASM is in the weak form efficient. However, Dockery and Kuvassanos (1996) applied unit root tests and Wald statistical test to the monthly data on 73 companies quoted on the ASM for the period from February 1988 to October 1994 and concluded that the ASM is not informationally inefficient.

Smith and Ryoo (2003) employed the multiple variance ratio tests to test the random walk hypothesis for the sample of 5 European emerging markets — Greece, Hungary, Poland, Portugal and Turkey. They used the weekly data beginning in the third week of April 1991 and ending in the last week of August 1998. In 4 markets, the random walk hypothesis is rejected because of autocorrelation in returns, whereas for the case of Turkey it was found that the Istanbul Stock Exchange (ISE) follows a random walk. These results, for the ISE, are consistent with Antoniou et al. (1997). These authors used an augmented logistic map model to test the efficiency of the ISE for the period from 1988 to 1993. The results showed that up to 1990 the market was inefficient and the inefficiency was marked by non-linear behaviour. This non-linear behaviour resulted from the information unreliability, low volume of trading, illiquidity and unrestricted insider trading. To address these shortcomings, the ISE went through a period of the extensive liberalisation and regulatory changes from late 1989 to 1992. Consequently, the test results showed that from 1991 onwards the ISE market proved to be informationally efficient.

Furthermore, Gilmore and McManus (2003) tested the weak-form efficiency of the equity markets of the 3 main Central European transition economies — Czech Republic, Hungary and Poland for the period July 1995 through September 2000 using weekly data of stock indices. They applied a variety of tests, including univariate methods and multivariate tests, as well as a model comparison approach. While the serial correlation-based tests supported the weak-form efficiency, the model-comparison approach rejected the random walk hypothesis. Their overall conclusion was that there is strong evidence that stock prices at these markets do not follow a random walk but do exhibit some dependency as captured by ARIMA and GARCH models.

In this study we will test whether the stock market in Serbia exhibit at least weak form efficiency, thus supporting the economic growth and prosperity of the country. First, the market overview will be given. Then, the data and the methodology will be explained, followed by the empirical results and concluding remarks.

2. The Market Overview and Data Analysis. Although the BSE as an institution exists over a century, the true operations concerning shares have started in October 2004 with the introduction of the continuous trading method. The number of companies at the BSE has increased after initialisation of privatisation in 2001. In 2003 there were 335 companies, in 2004 — 390 companies, in 2005 — 860, and today there are 1,271 companies listed at the unregulated market. There are only 5 companies currently listed on the Listing A — prime market and 3 companies listed on the Listing B — standard market of the BSE. The reason for this current situation are strict listing requirements according to the rules of the exchange, concerning size of a company, shares liquidity, number of shareholders etc.

Table 1. **Development of the BSE from 2001 to 2011**

Year	Turnover (in EUR mln)	Number of transactions (in 000)	Market capitalisation (% of GDP)	Total value of traded stocks (% of GDP)	Turnover ratio (%)
2001	841	46	-	0.01	-
2002	1,685	84	4.86	0.73	-
2003	1,420	128	7.20	2.72	49.80
2004	557	139	13.84	1.87	18.85
2005	581	174	21.43	2.64	15.34
2006	1,210	141	37.59	4.58	16.35
2007	2,060	301	60.77	6.48	14.61
2008	882	119	24.90	2.55	6.92
2009	441	77	27.66	1.35	4.75
2010	222	726	24.76	0.61	2.23
2011	280	2,888	-	-	3.69

Note: —indicates that data are not available.
Source: http://www.belex.rs; http://databank.worldbank.org.

Table 1 illustrates the development of the BSE by considering several indicators for the period 2001-2011. The turnover, number of transactions and market capitalisation had steady growth until 2008 when financial crisis begun. In 2008 the turnover was almost 3 times lower than in the previous year, and the negative trend continued until 2011 showing slight recovery comparing to 2010. However, these numbers are still far from those achieved in 2007 — 7 times smaller.

The importance of market capitalisation ratio lies in the fact that "the size of the stock market is positively correlated with the ability to mobilize capital and diversify risk" (Levine and Zervos, 1996, p. 328). The size of Serbian stock market has been significantly reduced since 2007, but still this market incorporates almost 1/4 of the economy.

Beside the size, the liquidity of the market, which is also important, can be measured by two indicators — the ratio of the total value of traded stocks to GDP and the ratio of the total value of trades on the exchange divided by market capitalisation (turnover ratio). First ratio measures the value of equity transactions relative to the size of the economy and complements the market capitalisation ratio, since markets may be large but inactive. This is the case with Serbian market because the value of the traded stocks is only 0.61% of GDP in 2010.

The second ratio measures the value of equity transactions relative to the size of equity market and indicates that even though markets may be small (compared with the whole economy) they can be liquid. These indicators do not measure the easiness with which stocks are bought and sold, but the degree of trading compared with the size of the economy and the market. Accordingly, the stock market in Serbia is characterized with low liquidity like many emerging markets.

The data used in this study consist of the daily closing prices of the two indices from the BSE — BELEX15 and BELEXline.

BELEX15 is positioned as leading index of BSE with the purpose to closely describe movements of the most liquid shares, while BELEXline index is designed as basic benchmark for following the movements in prices at Serbian capital market.

The historical data covers the time period from 4 October 2005 to 31 December 2011 of 1575 trading days for BELEX15 and from 1 October 2004 to 31 December

2011 of 1828 trading days for BELEXline. The data are obtained from the official website of the BSE.

Concerning the fact that working directly with the price series is not preferable for numerous reasons[3], daily data of the price indices are converted into series of returns. Namely, returns have the added benefit that they are unit-free. The daily returns are computed as the continuously compounded returns which are the first difference in natural logarithm of the price indices:

$$R_t = \ln(P_t) - \ln(P_{t-1}) = \Delta \ln(P_t), \quad (1)$$

where P_t and P_{t-1} are the prices of the indices at time t and $t-1$.

Table 2. **Descriptive Statistics for the Daily Returns**

Statistics	BELEX15	BELEXline
Observations	1574	1827
Mean	-0.000441	-1.61E-05
Median	0.000000	0.000000
Maximum	0.121498	0.098644
Minimum	-0.108341	-0.069392
Standard deviation	0.016266	0.010665
Skewness	0.149951	0.245529
Kurtosis	13.09375	13.67559
Jarque-Bera statistic	6687.775	8694.194

Source: Authors' calculations.

Table 2 shows the basic statistics for the daily returns of BELEX15 and BELEXline. Mean is negative for both daily returns, thus suggesting that stock prices decrease over time.

The parameters skewness and kurtosis along with Jarque-Bera statistics are used to check whether the data set is normally distributed or not. Skewness for the normal distribution is zero and kurtosis is 3. Skewness for both indices is positive, thus indicating long right tail, while kurtosis is high above 3 indicating high peak, which can be seen from histograms presented in Figures 1 and 2. According to Jarque-Bera test statistics, the null hypothesis of normality is rejected for both indices.

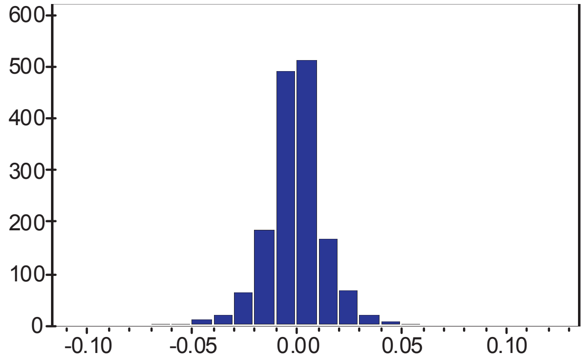

Figure 1. **Histogram of the BELEX15's Daily Returns**

[3] For the detailed explanation see Brooks (2002).

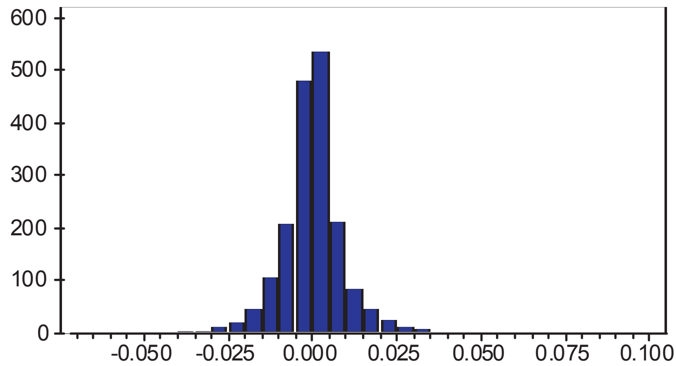

Figure 2. **Histogram of the BELEXline's Daily Returns**

As we see, the time series of returns on the BSE exhibit departure from normal distribution similarly to other emerging and developing markets. This characteristic is important for decision on the methodology for this research.

3. The Methodology. In order to examine the weak-form efficiency, tests of randomness will be conducted first, followed by the tests for non-linear dependences. For testing randomness we will employ portmanteau tests, unit root tests and single variance ratio test.

The most intuitive test of random walk is to check for serial correlation (Fama, 1965). A time series is random if all the autocorrelation coefficients are zero. Autocorrelation coefficients estimate the correlation between a variable and itself at particular lags (Hamilton, 2004). The k-th order autocorrelation coefficient (ρ_k) is defined as:

$$\rho_k = \frac{\mathrm{cov}(r_t, r_{t-k})}{V(r_t)}, \tag{2}$$

where k is the time lag and r returns at time t. In order to test statistical significance of any individual autocorrelation coefficient it is necessary to construct a confidence interval for an estimated autocorrelation coefficient to determine whether it is significantly different from zero (Gujarati, 2003). For instance, a 95% confidence interval would be given by

$$\pm 1.96 \frac{1}{\sqrt{n}}$$

where n is a sample size. If the sample autocorrelation coefficient falls outside this preceding interval for a given values of k, then the null hypothesis that the true ρ_k at that lag k is zero is rejected.

In practice, the joint hypothesis, that all the autocorrelation coefficients up to certain lags are simultaneously equal to zero, can be tested by applying Ljung and Box (1978) statistics:

$$Q^* = n(n+2)\sum_{k=1}^{m}\left(\frac{\hat{\rho}_k^2}{n-k}\right) \sim \chi^2 m, \tag{3}$$

where n is sample size and m is lag length. Q^* statistic test

$$H_0 : \rho_1 = \rho_2 = \ldots = \rho_m = 0$$

against

$$H_1 : \rho_k \neq 0 for \text{ some } k \in \{1,\ldots,m\}$$

If the computed Q^* exceeds the critical Q^* value from the χ^2 distribution at the chosen level of significance, the null hypothesis can be rejected. Although commonly used, the power of this Q^* statistic depends on the choice of m. Thus, in order to provide better performance Tsay (2005) suggested the choice of $m \approx \ln(n)$.

Given that Ljung-Box test statistic cannot be used to detect non-linear dependence, the BDS tests (proposed by Brock, Dechert and Sheinkman) will be conducted to check for non-linear dependence. The BDS statistics is given by:

$$b_{m,n}(\varepsilon) = c_{m,n}(\varepsilon) - c_{1,n-m+1}(\varepsilon)^m, \tag{4}$$

and is expected to be close to zero under the assumption of independence. As suggested by Blasco et al. (1997) embedding dimension — m should be 5 or lower, and should be between 0.5 and 2 standard deviations of the data. Specifically, the hypotheses under the BDS test are:

H_0: the data are identically and independently distributed (IID)

H_1: the data are not IID.

Rejection of IID would indicate that returns are non-linear.

The non-linear dependence can be successfully described by an ARCH process (Poshakwale, 2002). Due to the fact that much of the non-linear dependence in financial time series occurs in volatility, ARCH models can be useful when forecast variance change over time and is predicted by past forecast errors. The ARCH LM test is a Lagrange multiplier (LM) test for autoregressive conditional heteroscedasticity (ARCH) in the residuals (Engle, 1982). For testing, we run the regression:

$$e_t^2 = \beta_0 + \left(\sum_{s=1}^{q} \beta_s e_{t-s}^2 \right) + v_t \tag{5}$$

where e is the residual. Test statistics is defined as nR^2 (the number of observations multiplied by the coefficient of multiple correlation) and is distributed as $\chi^2(q)$ (Brooks, 2002). The hypotheses are

$$H_0 : \beta_1 = \beta_2 = \ldots = \beta_q = 0$$

$$H_1 : \beta_s \neq 0 \text{ for some } s \in \{1,\ldots,q\}$$

If the value of the test statistic is greater than the critical value from the χ^2 distribution, then the null hypothesis should be rejected.

The importance of the unit root tests lies in their relation with the previous portmanteau tests in the sense that stationarity may be potential explanation for the dependence structure of the time series. Thus, the unit root hypothesis will be tested using the augmented Dickey-Fuller (ADF) test.

The ADF is based on the following regression equations (Gujarati, 2003):

$$\Delta Y_t = \delta Y_{t-1} + \alpha_i \sum_{i=1}^{k} \Delta Y_{t-1} + \varepsilon_t \text{ without constant and trend} \tag{6}$$

$$\Delta Y_t = \beta_1 + \delta Y_{t-1} + \alpha_i \sum_{i=1}^{k} \Delta Y_{t-1} + \varepsilon_t \text{ with constant, but no trend} \quad (7)$$

$$\Delta Y_t = \beta_1 + \beta_2 T + \delta Y_{t-1} + \alpha_i \sum_{i=1}^{k} \Delta Y_{t-1} + \varepsilon_t \text{ with constant and trend} \quad (8)$$

where Δ denotes the first difference, Y_t is the natural logarithm of the price indices, ε_t is a pure white noise error term, k is a lag length and T is deterministic time trend. The first equation is the test for a random walk against a stationary autoregressive process (AR) of order one, the second is the test for RW against a stationary AR(1) with drift, and the third is the test for RW against a stationary AR(1) with drift and a deterministic time trend (Brooks, 2002). The null hypothesis is that $\delta=0$, indicating that the series is non-stationary; whereas the alternative hypothesis is that $\delta < 0$. This test follows a tau statistic (τ). If the computed absolute value of τ statistic exceeds the critical value than H_0 should be rejected. Failing to reject H_0 implies that the time series of stock index returns has the property of random walk.

Another test important to our research is the variance ratio test. Namely, in order to evaluate the random walk properties of stock prices, Lo and MacKinlay (1988) developed the simple specification test sensitive to correlated price changes, but robust to many forms of heteroscedasticity and nonnormality. The variance ratio test is based on the premise that "the variance of the increments of the random walk is linear in the sampling interval" (p. 43). That is, the variance of X_t-X_{t-2} is twice the variance of X_t-X_{t-1}, where X_t=lnP_t and P_t is the stock price at time t. Lo and MacKinlay (1988) define the variance ratio $VR(q)$ as:

$$VR(q) = \frac{\sigma^2(q)}{\sigma^2(1)}, \quad (9)$$

where $\sigma^2(q)$ is $\frac{1}{q}$ the variance of the q-differences and $\sigma^2(1)$ is the variance of the first differences. The null hypothesis is that $VR(q)=1$. An estimated variance ratio less than one implies negative serial correlation, while a variance ratio greater than one implies positive serial correlation (Darrat and Zhong, 2000).

The values of $\sigma^2(1)$ and $\sigma^2(q)$ are given by Lo and MacKinlay (1988) as follow:

$$\sigma^2(q) = \frac{1}{m} \sum_{k=q}^{nq} (X_k - X_{k-q} - q\hat{\mu})^2 \quad (10)$$

$$\sigma^2(1) = \frac{1}{(nq-1)} \sum_{k=1}^{nq} (X_k - X_{k-1} - \hat{\mu})^2 \quad (11)$$

where

$$m = q(nq - q + 1)\left(1 - \frac{q}{nq}\right) \quad (12)$$

and

$$\hat{\mu} = \frac{1}{nq}(X_{nq} - X_0) \quad (13)$$

They developed test statistics for homoscedastic increments:

$$z(q) = \frac{VR(q) - 1}{\sqrt{\phi(q)}} \sim N(0,1) \quad (14)$$

where
$$\phi(q)=\frac{2(2q-1)(q-1)}{3q(nq)} \tag{15}$$

They also defined test statistics which is robust to heteroscedasticity:
$$z^*(q)=\frac{VR(q)-1}{\sqrt{\phi^*(q)}}\sim N(0,1), \tag{16}$$

where
$$\phi^*(q)=\sum_{j=1}^{q-1}\left[\frac{2(q-j)}{q}\right]^2\hat{\delta}(j) \tag{17}$$

and
$$\hat{\delta}(j)=\frac{\sum_{k=j+1}^{nq}(X_k-X_{k-1}-\hat{\mu})^2(X_{k-j}-X_{k-j-1}-\hat{\mu})^2}{\left[\sum_{k=1}^{nq}(X_k-X_{k-1}-\hat{\mu})^2\right]^2}. \tag{18}$$

Lo and MacKinlay (1988) demonstrate that both test statistics asymptotically follow standard normal distributions. Extensive Monte Carlo results reported in Lo and MacKinlay (1989) suggest that VR test performs better than either the Box-Pierce test of serial correlation or the Dickey-Fuller test of unit roots.

4. Empirical Results. The autocorrelation coefficients for the first 8 lags and Ljung-Box test statistics is given in Table 3. The every individual autocorrelation coefficient is reported as statistically significant if it is outside a ± 0.049 band for returns of the BELEX15 and ± 0.046 band for returns of the BELEXline[4].

Following Tsay (2005), the Ljung-Box test statistics Q*(7) and Q*(8) are reported for both indices[5]. Besides, the Ljung-Box statistics for first 6 lags are also presented to yield more comprehensive view.

The first order autocorrelation coefficients are positive and statistically significant for both indices. Additionally, the Ljung-Box statistics reported for all 8 lags are all significant at the 5% level for both indices. Therefore, the null hypothesis of no autocorrelation in the data is rejected suggesting that autocorrelation exists in daily return series.

Table 3. **Autocorrelations and Ljung-Box Test Statistics**

Number of lags (k)	BELEX15			BELEXline		
	ρ_k	*Q*(k)*	*p-values*	ρ_k	*Q*(k)*	*p-values*
1	0.343*	185.44*	0.000	0.391*	279.85*	0.000
2	0.149*	220.51*	0.000	0.211*	361.36*	0.000
3	0.010	220.67*	0.000	0.093*	377.36*	0.000
4	0.020	221.30*	0.000	0.106*	397.84*	0.000
5	-0.008	221.41*	0.000	0.068*	406.21*	0.000
6	0.013	221.67*	0.000	0.062*	413.32*	0.000
7	0.022	222.41*	0.000	0.068*	421.80*	0.000
8	0.067*	229.48*	0.000	0.114*	445.78*	0.000

Note: * Significant at the 5% level.
Source: Authors' calculations

[4] 95% confidence interval for BELEX15's returns is $\pm 1.96\frac{1}{\sqrt{1574}}=\pm 0.049$, and for BELEXline's returns is $\pm 1.96\frac{1}{\sqrt{1827}}=\pm 0.046$.

[5] The lag length for BELEX15 is $m\approx \ln(1574)\approx 7.36$ and for BELEXline is $m\approx \ln(1827)\approx 7.51$.

The significant first order autocorrelation in both return series suggests that ARMA (1, 0) would be a good specification to characterize daily returns. But, the series should be stationary before ARIMA models are used. Thus, the results of the ADF for daily returns of both indices obtained from STATA are presented in Table 4.

Table 4. **Augmented Dickey-Fuller Tests**

ADF tests	BELEX15		BELEXline	
	No trend	*With trend*	*No trend*	*With trend*
Test statistic value	-21.917	-21.956	-21.994	-22.213
1% critical value	-3.430	-3.960	-3.430	-3.960
5% critical value	-2.860	-3.410	-2.860	-3.410
10% critical value	-2.570	-3.120	-2.570	-3.120

Source: Authors' calculations.

The ADF tests with and without trend strongly reject the null hypothesis of a unit root at all 3 levels of significance, thus indicating stationarity of daily return series. This is in line with the Ljung-Box test's results. Besides, stationarity may possibly be an explanation for serial correlation of data. Up to this stage, the random walk hypothesis can be rejected for the stock market in Serbia.

In order to detect and remove any linear dependence before testing for nonlinearity, the BDS test is applied on the residuals of the ARMA (1, 0) model. The estimation results for the ARMA (1, 0) model are presented in Table 5.

Table 5. **Estimation Results for ARMA (1, 0) Model**

ARMA (1, 0)	BELEX15		BELEXline	
	coefficient	t-statistics	coefficient	t-statistic
μ	-0.000451	-0.769078	-2.23E-05	-0.059208
ϕ	0.342919	14.47165	0.391054	18.14904

Note: Critical value is 2.58 at the 1% significance level.
Source: Authors' calculations.

The results indicate that the coefficient for the first order autoregression is statistically significant for both BELEX15's and BELEXline's returns at the 1% level.

Table 6. **BDS Test Statistics for Residuals from ARMA (1, 0) Model**

ε	BELEX15				BELEXline			
m	0.5σ	σ	1.5σ	2σ	0.5σ	σ	1.5σ	2σ
2	13.00614	14.19693	15.78007	16.49388	13.78287	15.35858	16.09081	17.55244
3	17.41824	17.35638	18.63326	19.52063	17.30998	18.62027	18.97191	19.90467
4	21.44619	19.71820	20.16283	20.52950	21.09808	21.48798	20.92689	20.99304
5	26.78358	22.01774	21.13729	20.70114	26.21109	24.53065	22.46493	21.43488

Note: Critical value is 2.58 at the 1% significance level.
Source: Authors' calculations

The results reported in Table 6 reject the null hypothesis at the 1% level of significance for both indices. In other words, non-linear dependence is not absent from the series returns. Hence, in attempting to detect what type of nonlinearity is present in the data the Engle's test for the ARCH effects will be applied.

To test for heteroscedasticity, the ARCH LM test is applied to the residuals using Eviews and the results are reported in Table 7.

Table 7. **ARCH LM Test**

	BELEX15	BELEXline
nR^2	247.7235	286.8342
p-values	0.000000	0.000000

Source: Authors' calculations.

The results obtained are in favour of rejecting the null hypothesis, suggesting that the ARCH effects exist in the data and the ARMA (1, 0) model does not remove heteroscedasticity.

With the object of exploring whether the presence of heteroscedasticity and non normality can be the cause of the rejection of the random walk hypothesis, the variance ratio test is used. Using a base interval of one day, the single variance ratio tests proposed by Lo and MacKinlay for lags of 2, 4, 8, 16 and 32 days are conducted using MATLAB, and reported in Table 8.

Table 8. **Variance Ratio Tests Results**

Number of lags (*q*)	BELEX15			BELEXline		
	Number of observations = 1575			Number of observations = 1828		
	VR(q)	*z(q)*	*z*(q)*	*VR(q)*	*z(q)*	*z*(q)*
2	1.3445	13.6666*	6.0866*	1.3924	16.7745*	7.5595*
4	1.6739	14.2919*	6.6362*	1.8496	19.4102*	9.1327*
8	1.8759	11.7479*	5.9452*	2.3389	19.3471*	10.0510*
16	2.2678	11.4268*	6.3072*	3.1891	21.2579*	12.0670*
32	3.2299	13.8693*	8.4734*	4.7697	25.2607*	15.6680*

Note: *Indicates rejection of the random walk hypothesis at the 5% level of significance when using standard normal distribution.
Source: Authors' calculations

The reported results indicate that, under assumptions of homoscedasticity and heteroscedasticity, the null hypothesis can be rejected at the 5% significance level for every interval of q. Besides, the estimates of the variance ratio are larger than 1 for all cases. According to Lo and MacKinlay (1988), the variance ratios are approximately equal to one plus first-order autocorrelation coefficient, which is true for both indices

$$VR(2) \approx 1+\rho(1) = 1+0.343 = 1.343 \approx 1.3445$$

and

$$VR(2) \approx 1+\rho(1) = 1+0.391 = 1.391 \approx 1.3924$$

for BELEX15 and BELEXline respectively). Increasing feature of variance ratios with *q* implies positive serial correlation among returns.

The final results provide strong evidence of the rejection of the random walk hypothesis for the stock market in Serbia which cannot be attributed completely to the effects of time varying volatilities. In this sense, price changes can be potentially predictable over at least short time spans. Although this does not mean that it can be exploited in economic terms.

5. Conclusion. According to all the tests conducted in this research, the stock market in Serbia is inefficient, thus suggesting the potential obstacle for the economic growth of the country. The development of the country is based on the high-return projects that require long-term capital. But, investors are generally unwilling to give up control of their savings for long periods, and thus the liquidity of the capital market is highly important for maintaining economic growth. Liquid stock markets reduce the downside risk and costs of investing in projects that do not payoff for a long time, since investors can easily sell their stocks at the market and access their savings before the end of an investment project. Hence, more liquid stock markets ease investment in the potentially more profitable projects in the long run, thereby improving the allocation of capital and enhancing prospects for long-term growth. The impact of the stock market on the real economy is important, because investors from developed countries are accustomed to watch the market's evolution and to take into account the information regarding the economy's future (Stoica, 2002).

In the case of Serbia, although the market capitalisation constitutes almost 25% of the GDP, the liquidity of the market is very low, less than 1%, thus suggesting that there are many inactive stocks. Illiquidity and inefficiency of the stock market in Serbia could be due to the ineffective dissemination of information on performance of the listed companies and the limited role of professional financial intermediaries. Inefficient markets imply that price changes do not reflect all the known information. This fact diverts investors from the acquisition of information on firms, since they cannot profit based on this information. Therefore, neither the improved resource allocation will be achieved, nor the economic growth. Namely, market inefficiency brings insecurity to potential investors, especially when foreign investors are in question, and thus diminishes their motivation to invest in domestic securities. Consequently, firms cannot raise necessary funds for their expansion and large scale investment projects, which in turn lead to slower economic growth.

Further, inefficient market cannot reduce the principal-agent problem. Efficient markets enable manager compensation to be tied to stock performance, align the interests of managers and owners and promote efficient resource allocation and growth. However, inefficiency stimulates managers neither to maximize firm's equity price nor to impede takeover threats. According to Bekaert and Harvey (1998), extension of this idea to the whole economy indicates that "an efficient stock market can enhance growth by mitigating moral hazard and consequently increasing productivity" (p. 38).

Market inefficiency is also an obstacle for entrepreneurs, because the public offering is less viable as a result of high transaction costs or the uncertainty of attaining a fair value at the market. As a result, incentives for entering new ventures will be reduced, thus reducing overall long-term productivity of the economy.

Concerning all mentioned above, Serbian stock market is inefficient and illiquid. In order to have a functioning stock market mechanism, fulfilling its elemental function, we need savings, trust in the economy's perspectives, and an increasing production. Therefore, government should try to increase confidence in domestic capital market and attract foreign investors in order to improve market efficiency and enhance liquidity.

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